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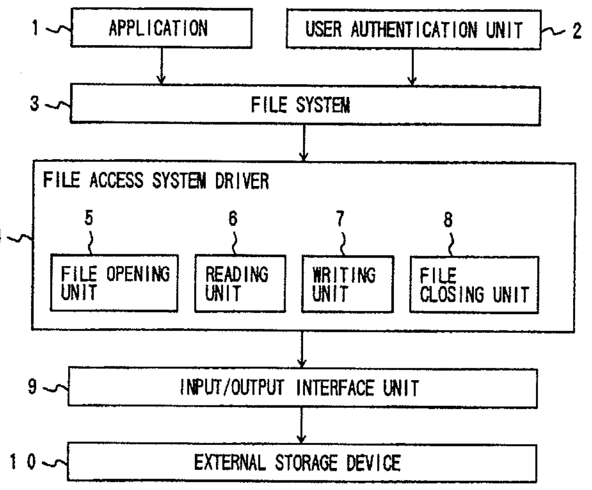
(54) File access system for efficiently accessing a file having encrypted data within a storage device

(57) A file access system includes a file opening unit (5) which opens a given file within a storage device (10) when a file opening request is issued by an application program (1). A determining unit (6, S44) determines whether a given file within the storage device has encrypted data when a reading request is issued by the application program. When the given file is determined as having the encrypted data, a reading unit (6, S50, S51) receives a fixed length of the encrypted data from the given file and generates a block of decrypted data of the same size as the fixed length by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the reading request.

FIG. 1


1 APPLICATION
USER AUTHENTICATION UNIT 2
3 FILE SYSTEM
FILE ACCESS SYSTEM DRIVER
4
5 FILE OPENING UNIT
6 READING UNIT
7 WRITING UNIT
8 FILE CLOSING UNIT
9 INPUT/OUTPUT INTERFACE UNIT
10 EXTERNAL STORAGE DEVICE

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Description

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to a file access system which accesses a file within an external storage device when a request to read data from or write data to the file is issued by an application program.

(2) Description of the Related Art

In a conventional file access method, a given file within an external storage device is accessed when a request is issued by an application program in order to read data from or write data to the file. In a case in which a file having encrypted data (or ciphertext) is accessed, the whole ciphertext from the file is copied to a working file. The whole ciphertext in the working file is decrypted into plaintext (or decrypted data), and the plaintext is copied to the working file. After the decryption is performed, the working file is accessed to obtain the plaintext. After the accessing procedure is performed, the plaintext is encrypted, and the encrypted data is copied to the file within the external storage device.

More specifically, in the conventional file access method, when encrypted data of a file within the external storage device is read by an application program, all the encrypted data from the file is copied to a working file. After the encrypted data is decrypted into plaintext in the working file, the working file is accessed to return the plaintext to the application program. After the accessing procedure is performed, the plaintext is encrypted into the ciphertext and the ciphertext (or the encrypted data) is copied to the file within the external storage device.

Therefore, when a file having encrypted data within the external storage device is accessed according to the conventional file access method, it is necessary to generate a working file and decrypt the data of the file to store the result of decryption in the working file. This makes it difficult to efficiently access the file having encrypted data within the external storage device.

Further, in the case of the conventional file access method, the plaintext (or the decrypted data) in the working file remains unprotected after the accessing procedure is finished, and there is a problem in that the conventional file access method fails to provide adequate security for information of the file within the external storage device.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved file access system in which the above-mentioned problems are eliminated.

Another object of the present invention is to provide a file access system which utilizes a simple accessing method and efficiently accesses a file within an external storage device even if the file has encrypted data.

Sill another object of the present invention is to provide a file access system which provides adequate security for information of a file within an external storage device even after the accessing procedure for the file is finished.

The above-mentioned objects of the present invention are achieved by a file access system in which a file within a storage device is accessed when a request is issued by an application program, the file access system comprising: a determining unit which determines whether a given file within the storage device has encrypted data when a reading request is issued by the application program; and a reading unit which receives a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the reading unit generating decrypted data of the same size as the fixed length by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the reading request.

The above-mentioned objects of the present invention are achieved by a file access system in which a file within a storage device is accessed when a request is issued by an application program, the file access system comprising: a determining unit which determines whether a given file within the storage device has encrypted data when a writing request is issued by the application program; and a writing unit which receives a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the writing unit generating decrypted data of the same size as the fixed length by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the writing request, and the writing unit overwriting new data from the application program to the decrypted data, and further the writing unit generating encrypted data of the same size as the fixed length by performing an encryption of the decrypted data, and overwriting the encrypted data to the given file at the position indicated by the writing request.

The file access system of the present invention, a simple encryption/decryption method is utilized to carry out the read/write processing. It is not necessary for the present invention to generate a working file and encrypt/decrypt data of a given file to store the result of encryption/decryption in the working file. The file access system of the present invention can efficiently access the given file within the external storage device. Further, in the file access system of the present invention, it is difficult to discriminate between a block of encrypted data and a block of decrypted data since both blocks have the same size. Therefore, the file access system of the present invention is effective in providing adequate security for information of the given file within the external storage device even after the accessing procedure for the file is finished.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of a file access system of the present invention;
FIG. 2 is a flowchart for explaining an initialization processing performed by the file access system;
FIG. 3 is a flowchart for explaining an encryption/decryption processing performed by the file access system associated with a user authentication unit;
FIG. 4 is a flowchart for explaining a file open processing performed by the file access system;
FIG. 5 is a flowchart for explaining a read processing performed by the file access system;
FIG. 6 is a flowchart for explaining a write processing performed by the file access system;
FIG. 7 is a flowchart for explaining a file close processing performed by the file access system;
FIG. 8 is a diagram for explaining a file management table registered by an operating system during the initialization processing; and
FIG. 9 is a diagram for explaining a user-level management table registered by the file access system during the encryption/decryption processing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A description will now be given of the preferred embodiment of the present invention with reference to the accompanying drawings.

FIG. 1 shows a configuration of a file access system of the present invention.

In FIG. 1, the file access system of the present invention is embodied in a file access system driver 4. An application 1 issues a request to a file system 3 in order to read data from or write data to a given file within an external storage device 10. The application 1 is an existing application program, and any modification of a source code of the application program is not needed when configuring the file access system of the present invention.

A user authentication unit 2 provides authentication of a user when an encryption/decryption processing for files within the external storage device 10 is performed, which will be described later with reference to FIG. 3.

In the file system 3, the file access system driver 4 carries out a file accessing procedure when a request is issued by the application 1, so that a given file within the external storage device 10 is accessed. The file system 3 is provided with an operating system (not shown in FIG. 1). The operating system provides a software platform on top of which the application 1 can run. Further, the file system 3 is provided with a central processing unit (CPU) and a memory, both of which are not shown in FIG. 1. The CPU carries out a processing according to the application 1 on top of the operating system in the file system 3, and the memory is used by the CPU when the processing according to the application 1 is performed.

The file access system driver 4 provides execution of various fundamental operations needed for the file accessing procedure. As shown in FIG. 1, the file access system driver 4 of the present embodiment comprises a file opening unit 5, a reading unit 6, a writing unit 7, and a file closing unit 8.

In the file access system driver 4, the file opening unit 5 causes the CPU to perform a file open processing to open a file within the external storage device 10, which will be described later with reference to FIG. 4.

The reading unit 6 causes the CPU to perform a read processing which will be described later with reference to FIG. 5. When a portion of a user-level management table (FIG. 9) for a folder containing a given file indicates that files in the folder have encrypted data, the reading unit 6 receives a fixed length of the encrypted data from the file and generates a block of decrypted data of the same size by performing the decryption. When the portion of the user-level management table for the folder indicates that the files in the folder have plaintext, the reading unit 6 returns the plaintext read from the file, to the application 1 without performing the decryption.

The writing unit 7 causes the CPU to perform a write processing which will be described later with reference to FIG. 6. When a portion of the user-level management table for a folder containing a given file indicates that files in the folder have encrypted data, the writing unit 7 receives a fixed length of the encrypted data from the file, generates a block of decrypted data of the same size by performing the decryption, and overwrites new data from a write buffer to the decrypted data. Further, the writing unit 7 receives a fixed length of the decrypted data from the data produced by the overwriting, and generates a block of encrypted data of the same size by performing the encryption, so that the resulting data is written to the file within the external storage device 10. When the portion of the user-level management table for the folder indicates that the files in the folder have plaintext, the writing unit 7 overwrites new data to the plaintext read from the file and writes the resulting data to the file within the external storage device 10 without performing the decryption/encryption.

The file closing unit 8 causes the CPU to perform a file close processing which will be described later with reference to FIG. 7.

In the file access system driver 4 of the present embodiment, a file accessing program related to the flowcharts of FIGs. 2-7 (which will be described later) is program code instructions stored in the memory of the file system 3. The memory of the file system 3 is, for example, a ROM (read-only memory). The memory corresponds to a computer readable medium in the claims. The computer readable medium includes any instruction storage device, such as for example, magnetic disks including floppy disks, optical disks including CD-ROMs, magneto-optical disks including MOs, semiconductor memory cards such as PC cards and miniature cards and other types of computer usable devices and media.

Further, in the present embodiment, the memory of the file system 3 may store encoded or non-encoded instructions. The instructions may first be installed from a floppy disk or a CD-ROM to a secondary memory (not shown) of the file system 3, transferred to a main memory (not shown) of the file system 3 and then read by the CPU. The memory of the file system 3 may store either all or a part of the program code instructions related to the flowcharts of FIGs. 2-7.

Referring back to FIG. 1, an input/output interface unit 9 provides an interface between the file access system driver 4 and the external storage device 10 when reading data from or writing data to a file within the external storage device 10. The external storage device 10 of the present embodiment is, for example, a hard disk drive (HDD) for a hard disk in which a plurality of files with either ciphertext or plaintext are stored.

Next, FIG. 2 shows an initialization processing performed by the file access system driver 4 of the present embodiment.

The file access system driver 4 of the present embodiment is, for example, a driver #1 which causes the CPU to perform a file access processing according to the present invention. In the following, the file access system driver 4 of the present embodiment will be called the driver #1, for the sake of simplicity of description.

As shown in FIG. 2, the operating system transmits a driver verification to the driver #1 (S1). When the driver verification from the operating system is received, the driver #1 causes the CPU to determine whether the driver #1 is ready to start execution of the initialization processing (S2).

When the result of the above S2 is negative, the driver #1 causes the CPU to return a negative acknowledgement of the received driver verification to the operating system. The operating system performs an error processing when the negative acknowledgement is received (S3).

On the other hand, when the result of the above S2 is affirmative, the driver #1 causes the CPU to return an acknowledgement of the received driver verification to the operating system. When the acknowledgement is received, the operating system accepts entry of the driver #1 into the operating system (S4). After the entry of the driver #1 in the above S4 is performed, the operating system transmits an initialization start command to the driver #1 (S5).

When the initialization start command is received, the driver #1 causes the CPU to issue to the operating system a request to hook the event in the file system 3 (S6). Specifically, when the event in the file system 3 is hooked, the driver #1 causes the CPU in the above step S6 to notify the operating system of a hook address ("FSHook (); ") of a program being called.

When the request in the above S6 is received, the operating system sets a corresponding portion of a file management table (FIG. 8) for the driver #1 at the hook address of the called program (S7). The file management table is registered with the memory of the file system 3 by the operating system in the above step S7.

As shown in FIG. 8, in the file management table, the hook address ("FSHook (); ") of the called program with respect to the driver #1, and another hook address of a program being called with respect to another driver are registered with the memory of the file system 3. The file management table provides the hook address of the called program with respect to the related driver for the operating system.

After the portion of the hook address in the above 57 is performed, the operating system transmits an acknowledgement of the received request to the driver #1.

After issuing of the request in the above S6 is performed, the driver #1 causes the CPU to determine whether the acknowledgement from the operating system is received (S8). When the result of the above S8 is affirmative, the initialization processing of FIG. 2 normally ends. In this case, the driver #1 is placed into a working condition for performing a file accessing procedure. On the other hand, when the result of the above S8 is negative, the initialization processing of FIG. 2 abnormally ends. In this case, an error processing is performed so as to ask the user to re-try the initialization or to provide the user with an error message.

FIG. 3 shows an encryption/decryption processing performed by the file access system driver 4 associated with the user authentication unit 2.

As shown in FIG. 3, when an encryption/decryption processing for files in the external storage device 10 is performed by the file access system driver 4, the user authentication unit 2 causes the CPU to ask the user to input a user ID and a password (S11).

After input of the user ID and the password in the above step S11 is performed, the user authentication unit 2 causes the CPU to determine whether the input user ID and password accords with a registered user ID and password (S12).

When the result of the above S12 is affirmative, the user authentication unit 2 causes the CPU to set a corresponding portion of the user-level management table (FIG. 9) for a folder (or a file directory) of the external storage device 10 based on an input setting for the folder by the user or the application 1 (S13). The corresponding portion of the user-level management table for the folder is set to indicate that the files in the folder have encrypted data. The folder in this case is called an encryption-type folder. A different folder may be included in the external storage device 10, which contains files having plaintext only. Such a folder is called a non-encryption-type folder.

When the result of the above S12 is negative, the user authentication unit 2 causes the CPU to perform an error processing so as to ask the user to re-try the inputting of a user ID and a password, or to provide the user with an error message.

After setting of the user-level management table in the above S13 is performed, the user authentication unit 2 causes the CPU to notify the driver #1 of the encryption-type folder for which the corresponding portion of the user-level management table has been set in the above S13 (S14).

When the notification in the above S14 is performed, the driver #1 causes the CPU to register the user-level management table, in which the corresponding portion for the folder is set as being the encryption-type folder, with the memory of the file system 3 (S15).

As shown in FIG. 9, a portion of the user-level management table for a folder indicates whether the encryption/decryption is to be performed after the read/write processing during the file accessing procedure. In the user-level management table of FIG. 9, "o" indicates that the files in the folder have encrypted data (the encryption-type folder), and "x" indicates that the files in the folder have plaintext (the non-encryption-type folder). In the encryption-type folder, the encryption/decryption must be performed after the read/write processing during the file accessing procedure. In the non-encryption-type folder, the encryption/decryption is not performed after the read/write processing during the file accessing procedure.

After the notification in the above S14 is performed, the user authentication unit 2 causes the CPU to request the driver #1 to start the encryption/decryption (S16).

When the request in the above S16 is performed, the driver #1 causes the CPU to start the encryption/decryption for files in the folder of the external storage device 10 (S17).

Accordingly, the user authentication unit 2 provides authentication of a user, and, only against an authorized user, the file access system driver 4 causes the CPU in the above step S15 to register the user-level management table in which a corresponding portion for a given folder is set as being the encryption-type folder. The corresponding portion of the user-level management table for the given folder indicates whether the encryption/decryption must be performed after the read/write processing during the file accessing procedure. Further, the file access system driver 4 causes the CPU in the above step S17 to start the encryption/decryption for files in the given folder of the external storage device 10.

FIG. 4 shows a file open processing performed by the file opening unit 5 of the file access system driver 4 before either the read processing or the write processing is started.

As shown in FIG. 4, the application 1 issues a file opening function to the file system 3 (S21). The file system 3 starts the file open processing to open a file within the external storage device 10 (S22).

When the file open processing is started in the above S22, the driver #1 (or the file opening unit 5) causes the CPU to receive an open event from the operating system (S23). The open event includes: a file name (including a path name); a file attribute; a file handle; file opening function parameters; a return address for the file system 3; and others.

The driver #1 causes the CPU to determine whether the portion of the user-level management table for the folder (indicated by the path name of the open event) indicates that the files in the folder have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing (S24).

When the result of the above S24 is negative, it is determined that the files in the folder indicated by the path name of the open event have plaintext and during the file accessing procedure the encryption/decryption is not performed after the read/write processing. The driver #1 causes the CPU to return to the return address for the file system 3 (S25).

When the result of the above S24 is affirmative, it is determined that the files in the folder indicated by the path name of the open event have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing. The driver #1 causes the CPU to determine whether the file attribute of the open event indicates that the file is irrelevant to the file accessing procedure (S27). For example, in cases of system files, hidden files and driver files, the file attributes of such files indicate that the files are irrelevant to the file accessing procedure. These files are excluded from the file accessing procedure.

When the result of the above S27 is affirmative, it is determined that the file is irrelevant to the file accessing procedure. The driver #1 causes the CPU to store the file handle of the open event into a file attribute table (not shown) (S28). After the updating of the file attribute table in the above S28 is performed, the driver #1 causes the CPU to return to the return address for the file system 3 (S29).

When the result of the above S27 is negative, it is determined that the file is relevant to the file accessing procedure. The driver #1 causes the CPU in the above S29 to return to the return address for the file system 3.

After the above step S29 is performed, the file system 3 finishes the file open processing (S30). The application 1 receives the file opening function from the file system 3 (S31).

Accordingly, when a file opening function is issued by the application 1, the file opening unit 5 of the file access system driver 4 causes the CPU to carry out the file open processing to open a file within the external storage device 10.

FIG. 5 shows a read processing performed by the reading unit 6 of the file access system driver 4 of the present embodiment.

As shown in FIG. 5, the application 1 issues a reading function to the file system 3 (S41). The file system 3 starts the read processing to read data from a given file within the external storage device 10 (S42).

When the read processing is started in the above S42, the driver #1 (or the reading unit 6) causes the CPU to receive a read event from the operating system (S43). The read event is called a reading request. The read event includes: a file name (including a path name); a file handle; a read point; a read buffer; a read size; a return address for the file system 3; and others.

When the read event is received in the above S43, the driver #1 causes the CPU to determine whether the portion of the user-level management table for the folder (indicated by the path name of the read event) indicates that the files in the folder have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing (S44).

When the result of the above S44 is negative, it is determined that the files in the folder indicated by the path name of the read event have plaintext and during the file accessing procedure the encryption/decryption has not to be performed after the read/write processing. The driver #1 causes the CPU to return to the return address for the file system 3 (S45). In this case, a normal read processing for the given file within the external storage device 10 is performed.

When the result of the above S44 is affirmative, it is determined that the files in the folder indicated by the path name of the read event have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing. The driver #1 causes the CPU to determine whether the file handle of the read event is included in the file attribute table which has been updated in the file open processing (S46).

When the result of the above S46 is affirmative, it is determined that the given file is irrelevant to the file accessing procedure. The driver #1 causes the CPU to return to the return address for the file system 3 (S47). In this case, the normal read processing for the given file within the external storage device 10 is performed.

When the result of the above S46 is negative, it is determined that the file is relevant to the file accessing procedure. The driver #1 causes the CPU to call a read processing in a HDD driver of the external storage device 10 (S48). In this case, a boundary processing is performed so as to read data from the given file within the external storage device 10.

The read processing of the HDD driver causes the CPU to read the encrypted data from the given file within the external storage device 10 through the boundary processing (S49).

After the above step S49 is performed, the driver #1 causes the CPU to receive a fixed length (for examples, 8 bytes) of the encrypted data from the given file and generate a block of decrypted data of the same size by performing the decryption (S50). This procedure is called a block decryption.

After the above step S50 is performed, the driver #1 causes the CPU to determine a position of the fixed length of the decrypted data by a position indicated by the read event, so that the decrypted data is set in the read buffer (S51).

After the above step S51 is performed, the driver #1 causes the CPU to return to the return address for the file system 3 (S52).

After the above step S52 is performed, the file system 3 finishes the read processing (S53). The application 1 receives the reading function with the read buffer from the file system 3 (S54).

Accordingly, when a reading function is issued by the application 1, the reading unit 6 of the file access system driver 4 causes the CPU to carry out the read processing to read data from a given file within the external storage device 10. Specifically, when a portion of the user-level management table for a folder containing the file indicates that the files in the folder have encrypted data, the reading unit 6 receives a fixed length of the encrypted data from the file and generates a block of decrypted data of the same size by performing the block decryption. When the portion of the user-level management table for the folder indicates that the files in the folder have plaintext, the reading unit 6 returns the plaintext read from the file, to the application 1 without performing the decryption.

In the file access system driver 4 of the present embodiment, a simple decryption method is utilized to carry out the read processing. Therefore, it is possible for the file access system driver 4 of the present embodiment to efficiently access the given file within the external storage device. Further, in the file access system driver 4 of the present embodiment, it is difficult to discriminate between a block of encrypted data and a block of decrypted data since both blocks have the same size. Therefore, it is possible for the file access system driver 4 of the present embodiment to provide adequate security for information of the given file within the external storage device even after the accessing procedure for the file is finished.

FIG. 6 shows a write processing performed by the writing unit 7 of the file access system driver 4 of the present embodiment.

As shown in FIG. 6, the application 1 issues a writing function to the file system 3 (S61). The file system 3 starts the write processing to write data to a given file within the external storage device 10 (S62).

When the write processing is started in the above S62, the driver #1 (or the writing unit 7) causes the CPU to receive a write event from the operating system (563). The write event is called a writing request. The write event includes: a file name (including a path name); a file handle; a write point; a write buffer; a write size; a return address for the file system 3; and others.

When the write event is received in the above S63, the driver #1 causes the CPU to determine whether the portion of the user-level management table for the folder (indicated by the path name of the write event) indicates that the files in the folder have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing (S64).

When the result of the above S64 is negative, it is determined that the files in the folder indicated by the path name of the write event have plaintext and during the file accessing procedure the encryption/decryption has not to be performed after the read/write processing. The driver #1 causes the CPU to return to the return address for the file system 3 (S65). In this case, a normal write processing for the given file within the external storage device 10 is performed.

When the result of the above S64 is affirmative, it is determined that the files in the folder indicated by the path name of the write event have encrypted data and during the file accessing procedure the encryption/decryption must be performed after the read/write processing. The driver #1 causes the CPU to determine whether the file handle of the write event is included in the file attribute table which has been updated in the file open processing (S66).

When the result of the above S66 is affirmative, it is determined that the given file is irrelevant to the file accessing procedure. The driver #1 causes the CPU to return to the return address for the file system 3 (S67). In this case, the normal write processing for the given file within the external storage device 10 is performed.

When the result of the above S66 is negative, it is determined that the file is relevant to the file accessing procedure. The driver #1 causes the CPU to call the read processing in the HDD driver of the external storage device 10 (S68). In this case, a boundary processing is performed so as to read data from the given file within the external storage device 10.

The read processing in the HDD driver causes the CPU to read the encrypted data from the given file within the external storage device 10 through the boundary processing (S69).

After the above step S69 is performed, the driver #1 causes the CPU to receive a fixed length (for examples, 8 bytes) of the encrypted data from the given file and generate a block of decrypted data of the same size by performing the block decryption (S70). Further, the driver #1 causes the CPU to determine a position of the fixed length of the decrypted data by a position indicated by the write event.

After the above step S70 is performed, the driver #1 causes the CPU to overwrite new data from the write buffer to the decrypted data which has been produced by the block decryption in the above step S70 (S71).

After the above step S71 is performed, the driver #1 causes the CPU to receives a fixed length (for example, 8 bytes) of the decrypted data from the decrypted data produced by the overwriting in the above S71 and generate a block of encrypted data of the same size by performing the encryption (S72). This encryption is called a block encryption.

After the above step S72 is performed, the driver #1 causes the CPU to call the write processing of the HDD driver of the external storage device 10 (S73). In this case, a boundary processing is performed so as to write data to the given file within the external storage device 10.

The write processing of the HDD driver causes the CPU to write the encrypted data from the driver #1 to the given file at the position indicated by the write event through the boundary processing (S74).

After the above step S74 is performed, the file system 3 finishes the write processing (S75). The driver #1 causes the CPU to return to the return address for the file system 3 (S76). The application 1 receives the writing function from the file system 3 (S77).

Accordingly, when a reading function is issued by the application 1, the writing unit 7 of the file access system driver 4 causes the CPU to carry out the write processing to write data from a given file within the external storage device 10. When a portion of the user-level management table for a folder containing the given file indicates that the files in the folder have encrypted data, the writing unit 7 receives a fixed length of the encrypted data from the file, generates a block of decrypted data of the same size by performing the block decryption, and overwrites new data from the write buffer to the decrypted data. Further, the writing unit 7 receives a fixed length of the decrypted data from the data produced by the overwriting, and generates a block of encrypted data of the same size by performing the block encryption, so that the resulting data is written to the given file within the external storage device 10. When the portion of the user-level management table for the folder indicates that the files in the folder have plaintext, the writing unit 7 overwrites new data from the write buffer to the plaintext read from the file and writes the resulting data to the file within the external storage device 10 without performing the decryption/encryption.

In the file access system driver 4 of the present embodiment, a simple encryption/decryption method is utilized to carry out the write processing. Therefore, it is possible for the file access system driver 4 of the present embodiment to efficiently access the given file within the external storage device. Further, in the file access system driver 4 of the present embodiment, it is difficult to discriminate between a block of encrypted data and a block of decrypted data since both blocks have the same size. Therefore, it is possible for the file access system driver 4 of the present embodiment to provide adequate security for information of the given file within the external storage device even after the accessing procedure for the file is finished.

FIG. 7 shows a file close processing performed by the file closing unit 8 of the file access system driver 4 of the present embodiment after either the read processing or the write processing is performed.

As shown in FIG. 7, the application 1 issues a file closing function to the file system 3 (S81). The file system 3 starts the file close processing to close a file within the external storage device 10 (S82).

When the file close processing is started in the above S82, the driver #1 (or the file closing unit 8) causes the CPU to receive a close event from the operating system (S83). The close event includes: a file name; a file handle; a return address for the file system 3; and others.

The driver #1 causes the CPU to determine whether the portion of the user-level management table for the folder (indicated by the file name of the close event) indicates that the files in the folder have encrypted data (S84).

When the result of the above S84 is negative, it is determined that the files in the folder indicated by the file name of the close event have plaintext. The driver #1 causes the CPU to return to the return address for the file system 3 (S85). In this case, a normal file close processing for the given file within the external storage device 10 is performed.

When the result of the above S84 is affirmative, it is determined that the files in the folder indicated by the file name of the close event have encrypted data. The driver #1 causes the CPU to determine whether the file handle of the close event is included in the file attribute table which has been updated in the file open processing (S86).

When the result of the above 586 is negative, the driver #1 causes the CPU to return to the return address for the file system 3 (S87). In this case, the normal file close processing for the given file within the external storage device 10 is performed.

When the result of the above S86 is affirmative, the driver #1 causes the CPU to delete the file handle of the close event from the file attribute table (S89). After the updating of the file attribute table in the above 589 is performed, the driver #1 causes the CPU to return to the return address for the file system 3 (S90).

After the above step S90 is performed, the file system 3 finishes the file close processing (S91). The application 1 receives the file closing function from the file system 3 (S92).

Accordingly, when a file closing function is issued by the application 1, the file closing unit 8 of the file access system driver 4 causes the CPU to carry out the file close processing to close a file within the external storage device 10.

As described above, in the file access system of the present invention, a simple encryption/ decryption method is utilized to carry out the read/ write processing. It is not necessary for the present invention to generate a working file and encrypt/ decrypt data of a given file to store the result of encryption/decryption in the working file. Therefore, the file access system of the present invention is effective in increasing the access speed at which a given file within the external storage device is accessed. Further, in the file access system of the present invention, it is difficult to discriminate between a block of encrypted data and a block of decrypted data since both blocks have the same size. Therefore, the file access system of the present invention is effective in providing adequate security for information of the given file within the external storage device even after the accessing procedure for the file is finished.

Further, the present invention is not limited to the above-described embodiments, and variations and modifications may be made without departing from the present invention.

Claims

1. A file access system in which a file within a storage device is accessed when a request is issued by an application program, comprising:

   a determining unit (6, S44) for determining whether a given file within the storage device (10) has encrypted data when a reading request is issued by the application program (1); and
   a reading unit (6, S50, S51) for receiving a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the reading unit generating decrypted data of the same size as the fixed length by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the reading request.

2. The file access system according to claim 1, characterized in that said system further comprises a file opening unit (5) for opening a given file within the storage device (10) when a file opening request is issued by the application program (1).

3. A file access system in which a file within a storage device is accessed when a request is issued by an application program, comprising:

   a determining unit (6, S44) for determining whether a given file within the storage device (10) has encrypted data when a reading request is issued by the application program (1); and
   a reading unit (6, S50, S51) for receiving a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the reading unit generating decrypted data by performing a decryption where-

in a position of the fixed length of the decrypted data is determined by a position indicated by the reading request.

4. The file access system according to claim 3, characterized in that said system further comprises a file opening unit (5) for opening a given file within the storage device (10) when a file opening request is issued by the application program (1).

5. The file access system according to claim 1, characterized in that the determining unit (6, S44) determines whether a corresponding portion of a registered management table for the given file is set to indicate that the given file has encrypted data.

6. The file access system according to claim 2, characterized in that the file opening unit (5) determines whether the given file is irrelevant to a file accessing procedure based on a file attribute of the given file, and that, when the given file is determined as being irrelevant to the file accessing procedure, the file opening unit stores a file handle of the given file into a file attribute table.

7. A file access system in which a file within a storage device is accessed when a request is issued by an application program, comprising:

a determining unit (7, S64) for determining whether a given file within the storage device (10) has encrypted data when a writing request is issued by the application program (1); and
a writing unit (7, S70-573) for receiving a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the writing unit generating decrypted data of the same size as the fixed length by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the writing request, and the writing unit overwriting new data from the application program to the decrypted data, and further the writing unit generating encrypted data of the same size as the fixed length by performing an encryption of the decrypted data, and overwriting the encrypted data to the given file at the position indicated by the writing request.

8. The file access system according to claim 7, characterized in that said system further comprises a file opening unit (5) for opening a given file within the storage device (10) when a file opening request is issued by the application program (1).

9. A file access system in which a file within a storage device is accessed when a request is issued by an application program, comprising:

a determining unit (7, S64) for determining whether a given file within the storage device (10) has encrypted data when a writing request is issued by the application program (1); and
a writing unit (7, S70-S73) for receiving a fixed length of the encrypted data from the given file when the given file is determined as having the encrypted data, the writing unit generating decrypted data by performing a decryption wherein a position of the fixed length of the decrypted data is determined by a position indicated by the writing request, and the writing unit overwriting new data from the application program to the decrypted data, and further the writing unit generating encrypted data by performing an encryption of the decrypted data, and overwriting the generated encrypted data to the given file at the position indicated by the writing request.

10. The file access system according to claim 9, characterized in that said system further comprises a file opening unit (5) for opening a given file within the storage device (10) when a file opening request is issued by the application program (1).

11. The file access system according to claim 7, characterized in that the determining unit (7, 564) determines whether a corresponding portion of a registered management table for the given file is set to indicate that the given file has encrypted data.

12. The file access system according to claim 8, characterized in that the file opening unit (5, S27, S28) determines whether the given file is irrelevant to a file accessing procedure based on a file attribute of the given file, and that, when the given file is determined as being irrelevant to the file accessing procedure, the file opening unit stores a file handle of the given file into a file attribute table.

FIG. 1

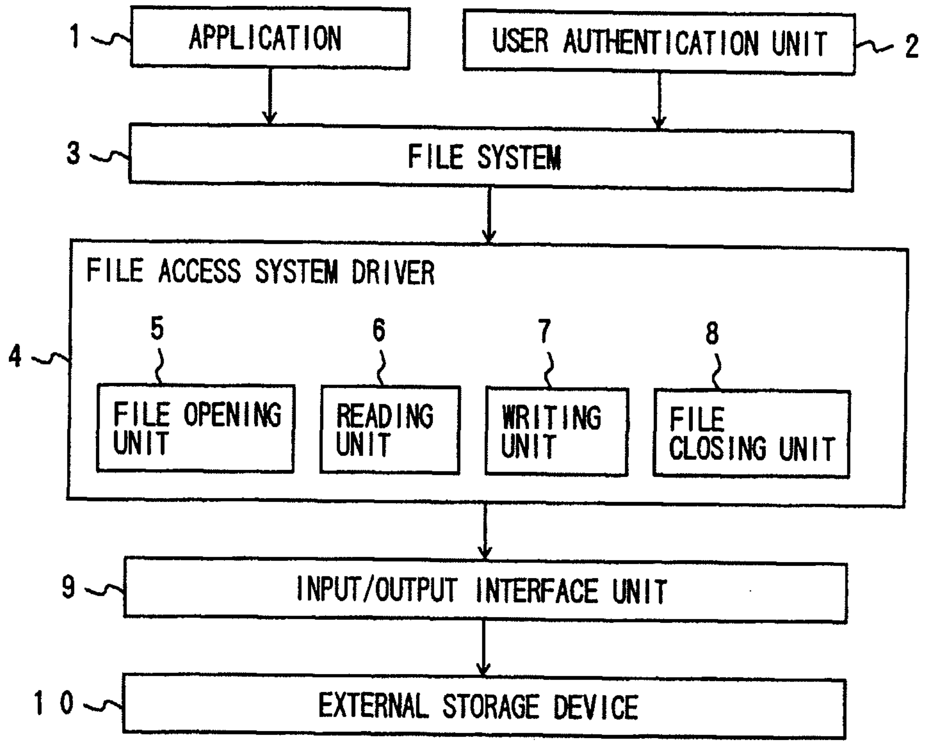
1
APPLICATION
USER AUTHENTICATION UNIT
2
3
FILE SYSTEM
FILE ACCESS SYSTEM DRIVER
4
5
6
7
8
FILE OPENING UNIT
READING UNIT
WRITING UNIT
FILE CLOSING UNIT
9
INPUT/OUTPUT INTERFACE UNIT
1 0
EXTERNAL STORAGE DEVICE

FIG. 2

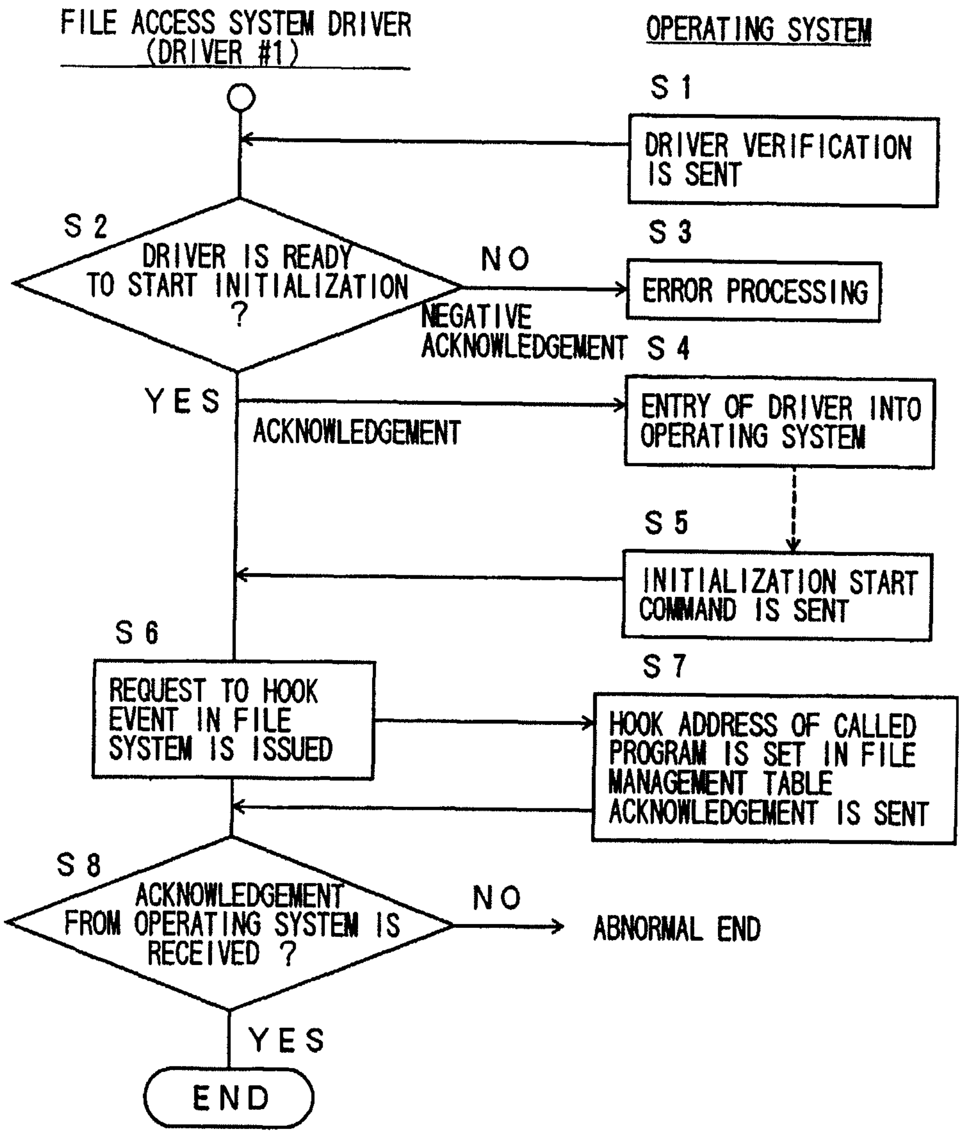
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
OPERATING SYSTEM
S 1
DRIVER VERIFICATION IS SENT
S 2
DRIVER IS READY TO START INITIALIZATION ?
NO
S 3
ERROR PROCESSING
NEGATIVE ACKNOWLEDGEMENT
S 4
YES
ACKNOWLEDGEMENT
ENTRY OF DRIVER INTO OPERATING SYSTEM
S 5
INITIALIZATION START COMMAND IS SENT
S 6
REQUEST TO HOOK EVENT IN FILE SYSTEM IS ISSUED
S 7
HOOK ADDRESS OF CALLED PROGRAM IS SET IN FILE MANAGEMENT TABLE ACKNOWLEDGEMENT IS SENT
S 8
ACKNOWLEDGEMENT FROM OPERATING SYSTEM IS RECEIVED ?
NO
ABNORMAL END
YES
END

FIG. 3

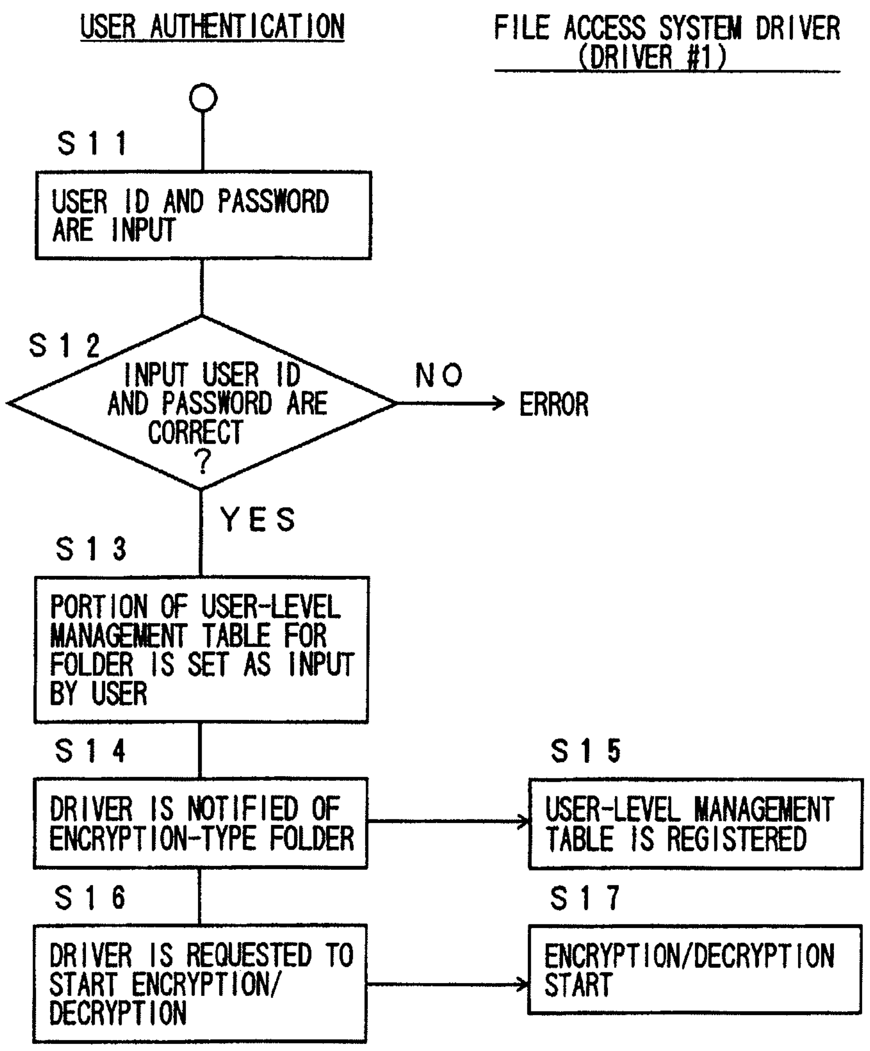
USER AUTHENTICATION
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
S11
USER ID AND PASSWORD ARE INPUT
S12
INPUT USER ID AND PASSWORD ARE CORRECT ?
NO
ERROR
YES
S13
PORTION OF USER-LEVEL MANAGEMENT TABLE FOR FOLDER IS SET AS INPUT BY USER
S14
DRIVER IS NOTIFIED OF ENCRYPTION-TYPE FOLDER
S15
USER-LEVEL MANAGEMENT TABLE IS REGISTERED
S16
DRIVER IS REQUESTED TO START ENCRYPTION/ DECRYPTION
S17
ENCRYPTION/DECRYPTION START

FIG. 4

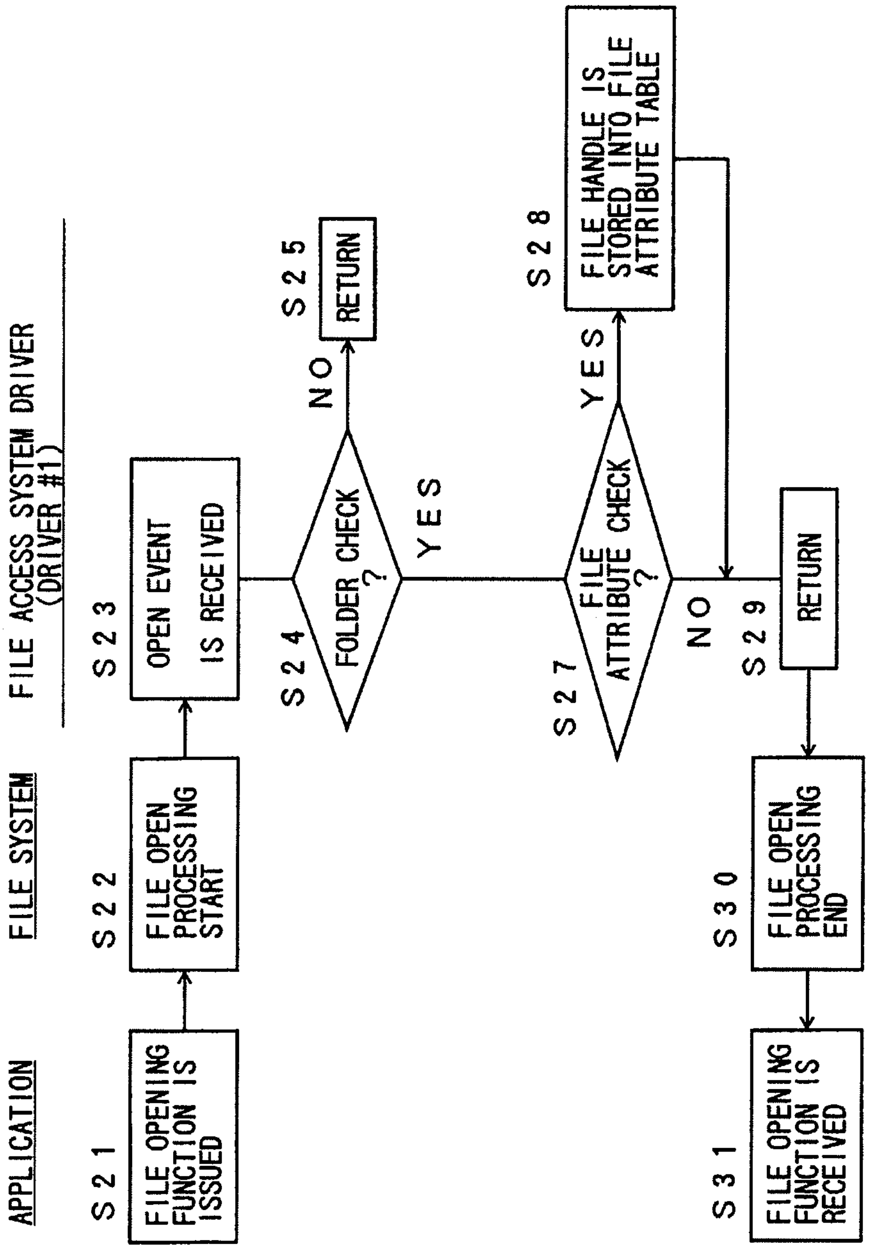
APPLICATION
FILE SYSTEM
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
S21
FILE OPENING FUNCTION IS ISSUED
S22
FILE OPEN PROCESSING START
S23
OPEN EVENT IS RECEIVED
S24
FOLDER CHECK ?
NO
S25
RETURN
YES
S27
FILE ATTRIBUTE CHECK ?
YES
S28
FILE HANDLE IS STORED INTO FILE ATTRIBUTE TABLE
NO
S29
RETURN
S30
FILE OPEN PROCESSING END
S31
FILE OPENING FUNCTION IS RECEIVED

FIG. 5

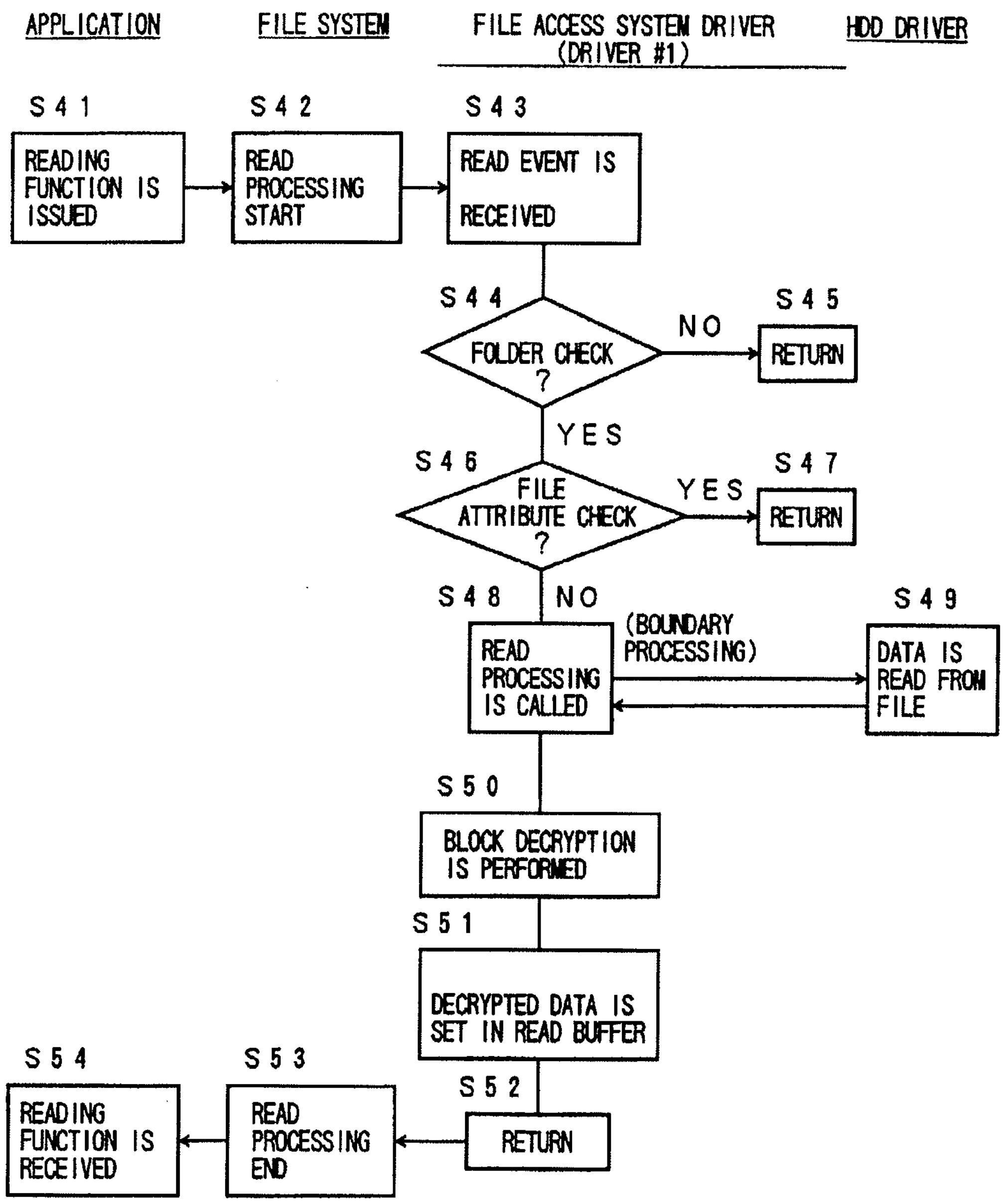
APPLICATION
FILE SYSTEM
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
HDD DRIVER
S41
READING FUNCTION IS ISSUED
S42
READ PROCESSING START
S43
READ EVENT IS RECEIVED
S44
FOLDER CHECK ?
NO
S45
RETURN
YES
S46
FILE ATTRIBUTE CHECK ?
YES
S47
RETURN
S48
NO
READ PROCESSING IS CALLED
(BOUNDARY PROCESSING)
S49
DATA IS READ FROM FILE
S50
BLOCK DECRYPTION IS PERFORMED
S51
DECRYPTED DATA IS SET IN READ BUFFER
S52
RETURN
S53
READ PROCESSING END
S54
READING FUNCTION IS RECEIVED

FIG.6

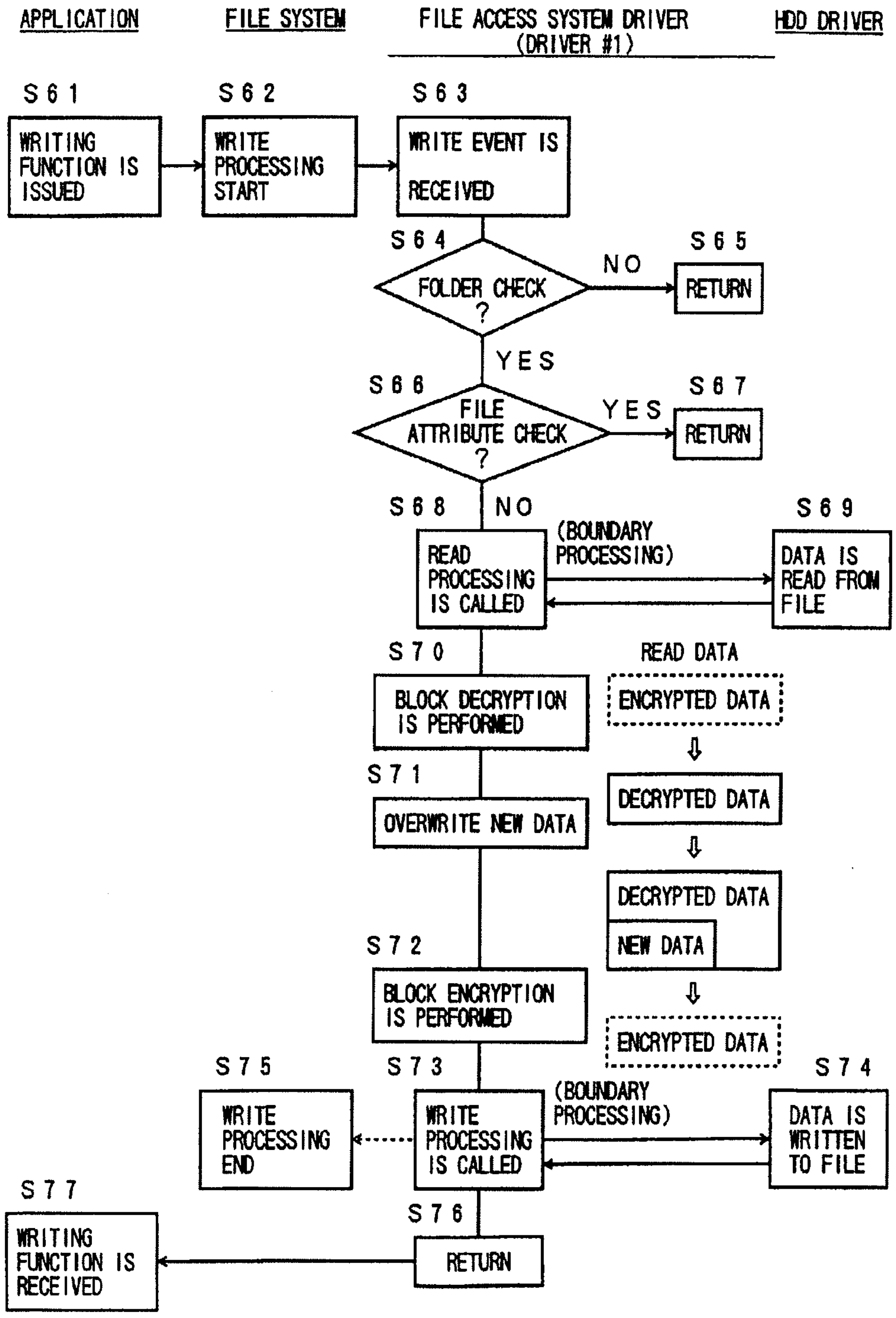
APPLICATION
FILE SYSTEM
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
HDD DRIVER
S61
WRITING FUNCTION IS ISSUED
S62
WRITE PROCESSING START
S63
WRITE EVENT IS RECEIVED
S64
FOLDER CHECK ?
NO
S65
RETURN
YES
S66
FILE ATTRIBUTE CHECK ?
YES
S67
RETURN
S68
NO
READ PROCESSING IS CALLED
(BOUNDARY PROCESSING)
S69
DATA IS READ FROM FILE
S70
BLOCK DECRYPTION IS PERFORMED
READ DATA
ENCRYPTED DATA
DECRYPTED DATA
S71
OVERWRITE NEW DATA
DECRYPTED DATA
NEW DATA
S72
BLOCK ENCRYPTION IS PERFORMED
ENCRYPTED DATA
S75
WRITE PROCESSING END
S73
WRITE PROCESSING IS CALLED
(BOUNDARY PROCESSING)
S74
DATA IS WRITTEN TO FILE
S77
WRITING FUNCTION IS RECEIVED
S76
RETURN

FIG. 7

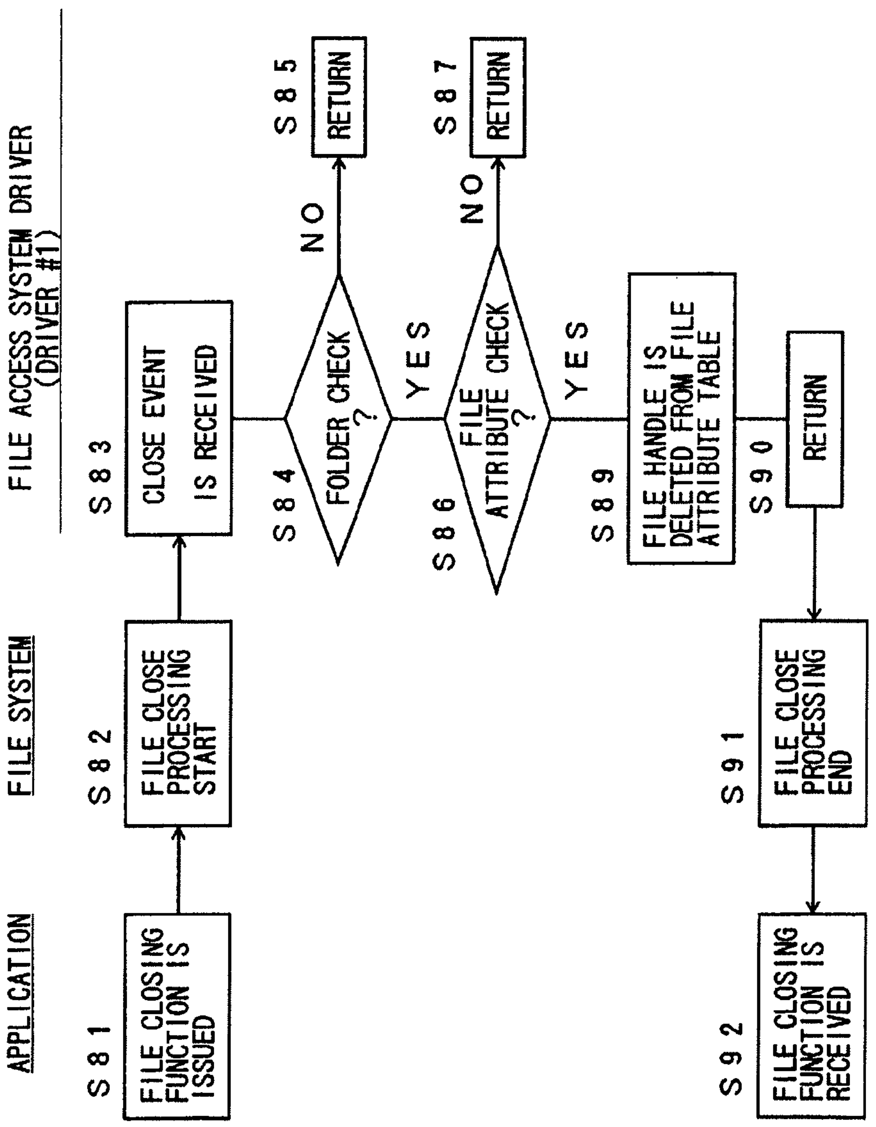
APPLICATION
FILE SYSTEM
FILE ACCESS SYSTEM DRIVER (DRIVER #1)
S81
FILE CLOSING FUNCTION IS ISSUED
S82
FILE CLOSE PROCESSING START
S83
CLOSE EVENT IS RECEIVED
S84
FOLDER CHECK ?
NO
S85
RETURN
YES
S86
FILE ATTRIBUTE CHECK ?
NO
S87
RETURN
YES
S89
FILE HANDLE IS DELETED FROM FILE ATTRIBUTE TABLE
S90
RETURN
S91
FILE CLOSE PROCESSING END
S92
FILE CLOSING FUNCTION IS RECEIVED

FIG. 8

FILE MANAGEMENT TABLE

DRIVER NAME	HOOK ADDRESS
DRIVER #1	FSHook ( ) ;
DRIVER #2	FSHook ( ) ;
⋮	⋮

FIG. 9

USER-LEVEL MANAGEMENT TABLE

FOLDER NAME	READ PROCESSING	WRITE PROCESSING
FOLDER A	○	○
FOLDER B	○	×
FOLDER C	×	○
FOLDER D	×	×

○ : ENCRYPTION-TYPE FOLDER
× : NON-ENCRYPTION-TYPE FOLDER